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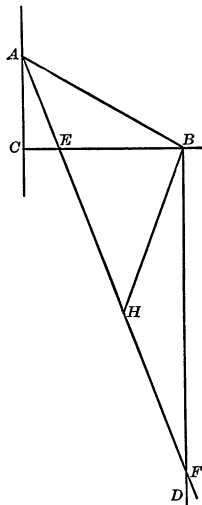
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Also solved by E. H. VANCE, J. B. REYNOLDS, and WILLIAM HOOVER.

513. Proposed by ALBERT A. BENNETT, University of Texas.

The following construction for angle trisection was given some years ago in a non-mathematical journal. Let ABC be a right triangle with AB as hypotenuse. Let BD be a ray drawn parallel to AC and extending in the same direction. Let AEF be a variable ray meeting the segment BC in E and the ray BD in F . Show, by elementary methods, that when the variable ray is so adjusted that $EF = 2AD$ then $\angle EAC = \frac{1}{3} \angle BAC$.



SOLUTION BY JOS. B. REYNOLDS, Lehigh University.

I take it that the reading should be $EF = 2AB$. Let the figure be constructed according to the given directions. Join B to H , the middle point of EF . Now $BH = HE = HF = AB$ so that the triangles ABH and BHF are isosceles and, therefore,

$$\angle BAE = \angle BHA = 2 \angle BFH = 2 \angle EAC.$$

Hence,

$$\angle EAC = \frac{1}{3} \angle BAC.$$

Also solved by S. W. REAVES and HORACE OLSON.

MECHANICS.

337. Proposed by CLIFFORD N. MILLS, Brookings, South Dakota.

Assuming that a train may be accelerated by the application of a force equal to $1/40$ of its gross weight and be braked with a force equal to $1/10$ of its gross weight, show that the least time in which it may run from one to another of two stopping stations 5,000 feet apart is 2 minutes and 5 seconds. Also find the greatest speed during the run to be $54\text{-}6/11$ miles per hour.

SOLUTION BY CAPTAIN STUART C. GODFREY, West Point, N. Y.

A force applied to a body equal to one fortieth of its weight will produce an acceleration of $g/40 = 32/40 = 4/5$ ft. per sec².

Then $\alpha_1 = 4/5 =$ increasing acceleration during first period of train's motion.

$\alpha_2 = 32/10 = 16/5 =$ decreasing acceleration during final period of train's motion.

Let t_1 and t_2 represent the corresponding time intervals, and let $V_1 = \alpha_1 t_1 = \alpha_2 t_2 =$ maximum speed attained.

Since $\alpha_2 = 4\alpha_1$, $t_2 = 1/4 t_1$. Also, since $s = 1/2 \alpha t^2$, the distance corresponding to the final period is

$$\frac{1}{2} \alpha_2 t_2^2 = \frac{1}{2} \left(4\alpha_1 \cdot \frac{t_1^2}{4^2} \right) = \frac{1}{4} (\frac{1}{2} \alpha_1 t_1^2) = \frac{1}{4}, \text{ of the distance for the first period.}$$

Now if the reasonable assumption be made that the speed of the train continues to accelerate until the moment when the brakes must be applied to bring it to a stop at the final station, the problem is readily solved without using the maxima and minima method.

For the distances are obviously 4,000 feet and 1,000 feet.

$$t = \sqrt{\frac{2s_1}{\alpha_1}} = \sqrt{\frac{8000 \cdot 5}{4}} = 100 \text{ secs.}$$

$$t_2 = \frac{t_1}{4} = 25 \text{ secs. Total time} = 2 \text{ min. } 5 \text{ secs.}$$

Also $V_1 = \alpha_1 t_1 = 4/5 \cdot 100 = 80$ ft. per sec. = $54\text{-}6/11$ miles per hour.

More rigorously, it is conceivable that the train might retain its maximum speed V_1 for a period t_3 before the brakes were applied. Then, letting $4s$ and s represent the distances corresponding to the periods t_1 and t_2 , the time function in terms of s becomes (since $t = \sqrt{2s/\alpha}$)